THE SUSCEPTIBILITY OF TOKAY VINE VARIETIES TO *ERYSIPHE NECATOR* SCHWEIN., AND *PLASMOPARA VITICOLA* (BERK. & M.A.CURTIS) BERL. & DE TONI.

NÁCHYLNOSŤ TOKAJSKÝCH ODRÔD VINIČA NA *ERYSIPHE NECATOR* SCHWEIN., A *PLASMOPARA VITICOLA* (BERK. & M.A.CURTIS) BERL.&DE TONI.

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ABSTRACT

On defined production sites in the closed Tokay region only three varieties (cv. Lipovina, cv. Yellow Muscat and cv. Furmint) were grown for several centuries. Objective of the research from 2005-2008 was to examine whether there is a change in varieties susceptibility to *Plasmopara viticola* (Berk.& M.A.Curtis) Berl.&De Toni and *Erysiphe necator* Schwein., on four sites located from 105 to 320 AMSL were observed how the infection and pathogen spreading in both diseases were affected by climate factors, site location and the architecture of stand. We found out that the development and progression of infection depends on the susceptibility of leaves where fungi reproductive organs are growing and the dimension of infection source. The results showed that most sensitively responded to *Erysiphe necator* the Lipovina variety, with its very fine leaves. Cv. Furmint and cv. Muscat yellow were moderately responsive. Raphis and berries are very sensitive in all development stages. Dissemination of ascospores and *Erysiphe necator* conidia are spatially bounded, therefore, depending on microclimate, site location and stand architecture. The most sensitive response to infection by *Plasmopara viticola* was observed in cv. Lipovina, medium-sensitive in cv. Furmint, and the smallest in cv. Yellow Muscat. Especially young berries are very susceptible to infection. We found out that cv. Lipovina, Furmint and Yellow Muscat were most sensitive to infection by *Plasmopara viticola* and *Erysiphe necator* during the phenophase BBCH 68, when 80% of flowers fade away. The research found out that vines planted on sites with altitude from 105 to150 AMSL, in closed locations without any green work made were infected by *Plasmopara viticola* strongly.

Keywords: *Erysiphe necator*, *Plasmopara viticola*, source of infection, vine varieties

DETAILED ABSTRACT

Tokajská vinohradnícka oblasť leží medzi súradnicami 48°30´ zemepisnej šírky a 21° 37´až 21°46´zemepisnej dĺžky, na juhovýchodných až juhozápadných svahoch Zemplínskej vrchoviny. Zákonom č.313/2009 je definovaná uzavretá Tokajská oblasť (908,77 ha), vymedzené hony a odrody viniča (cv. Lipovina, cv. Muškát žltý, cv. Furmint). Špecifikom oblasti je pôda, ktorá je vytvorená na druhohorných andezitových a ryolitových tufoch, premiešané skeletom vulkanického pôvodu, ktorý vytvára priaznivý tepelný režim a mikroklímu pre pestovanie viniča [13]. Populácie tokajských odrôd viniča sú ohrozené genetickou eróziou [4]. Striktné podmienky dlhodobého monokultúrneho pestovania viniča a malá vnútrodruhová diverzita vytvárajú predpoklady pre vznik agresívnejšieho správania sa patogénov a zvýšený výskyt epidémií [8, 9].

Etiológia vzniku a priebehu *Plasmopara viticola* (Berk.& M.A.Curtis) Berl. &De Toni. a *Erysiphe necator* Schwein., je všeobecne známa, ale za veľmi dôležité považujeme sledovať a zachytiť zmeny správania patogénnej huby vo vzťahu k hostiteľovi i k prostrediu.

V rokoch 2005-2008 sme v poloprevádzkových pokusoch sledovali náchylnosť tokajských odrôd (cv. Lipovina, cv. Yellow Muscat, cv. Furmint) na napadnutie *Plasmopara viticola* (Berk.& M.A.Curtis) Berl.&De Toni a Erysiphe *necator* Schwein., v závislosti od klimatických faktorov, polohy pozemku, nadmorskej výšky a architektúry porastu viniča. Klimatickú charakteristiku Tokajskej oblasti v roku 2005-2008 sme zdokumentovali v grafoch (teplota a zrážky, teplota a ovlhčenie listov) a Walterových klimatografoch (obr. 1, 2, 3, 4). Pri sledovaní vplyvu počasia na nástup viniča do fenofáz (BBCH) sme zistili, že vinič v Tokajskej oblasti nastupuje do fenofáz len s nepatrnými odchýlkami až na rok 2007, kedy nastúpil do BBCH skôr o 14 dní (tab.1). Z variantov Pahorok(1) a Makovisko(2) v Malej Tŕni, SOU- Viničky(3), Kate-Čelejka (4) v Slovenskom Novom Meste, sme pravidelne odberali z neošetrovanej ako aj ošetrovanej parcely 100 ks listov a 50 ks strapcov odrôd cv. Lipovina, cv. Muškát žltý, cv. Furmint na diagnostiku chorôb. Stupeň napadnutia sme vyhodnocovali Towsendov a Heubergerovým vzorcom a dosiahnuté výsledky sme komparovali s ostatným výskumom v oblasti [18]. Percento napadnutia *Plasmopara viticola (*Berk.& M.A.Curtis) Berl.&De Toni a *Erysiphe necator* Schwein., uvádzame v tab. 4. a obr. 5, 6, 7, 8, 9, 10.

Z pokusov vyplynulo, že infekcia patogénmi závisí od náchylnosti odrody viniča, predovšetkým od citlivosti listov, na ktorých sa vytvárajú reprodukčné orgány huby. Zistili sme, že sledované odrody viniča sú najzraniteľnejšie na napadnutie *Plasmopara viticola* (Berk.&M.A.Curtis) Berl.&De Toni a *Erysiphe necator* Schwein., vo fenofáze BBCH 68, keď je 80% kvietkov odkvitnutých. Najcitlivejšie na infekciu *Erysiphe necator* reagovala odroda Lipovina, stredne citlivo reagoval Furmint a Muškát žltý (tab.4). Vekovo staršie listy boli odolnejšie proti infekcii. V tab. 2 uvádzame termíny objavenia sa prvých príznakov *Erysiphe necator* na listoch a strapcoch. Primárna infekcia v jarnom období nastáva na rube listu a tým sa vytvára silný infekčný tlak na strapce a bobule, ktoré sú veľmi citlivé v každom štádiu na múčnatku. Zistili sme, že čím dlhšie trvá obdobie od začiatku po koniec kvitnutia, tým dlhšie vzniká možnosť infekcie. Šírenie askospór a konídií *Erysiphe necator* je priestorovo ohraničené a závislé od mikroklimatických podmienok, polohy pozemku a architektúry porastu.

Za obdobie 2005-2008 sme mikroskopicky potvrdili výskyt oboch prezimujúcich tvarov (mycélia a kleistotécia) *Erysiphe necator.* V rokoch 2005 a 2006 sa kleistotécia stali zdrojom askospórovej jarnej infekcie. Zistili sme, že vznik prvej askospórovej infekcie závisí od teploty a dĺžky ovlhčenia listov a tým sme potvrdili autorov [5, 10, 17]. Ďalšie konídiové infekcie závisia od teplôt. Rez viniča, zelené práce ako sú odlisťovanie zóny strapcov a podlom významne znižujú možnosť infekcie a šírenie sa huby. V prehustených kroch sa vytvárajú priaznivejšie tepelné a vlhkostné podmienky pre ďalšiu infekciu a šírenie huby. Naše výsledky potvrdili, že kleistotéciová forma ako primárny zdroj infekcie múčnatky má v Tokajskej oblasti dôležitú epidemiologickú úlohu.

Z dosiahnutých výsledkov vyplynulo, že v rokoch 2005, 2006 a 2008 boli vytvorené klimatické podmienky pre silný výskyt *Plasmopara viticola*. Najcitlivejšie na napadnutie *Plasmopara viticola* reagovala odroda Lipovina, stredne citlivo reagovala odroda Furmint, najmenej Muškát žltý (tab. 4). Veľmi náchylné sú mladé bobule. V tab. 3 uvádzame termíny objavenia sa prvých príznakov *Plasmopara viticola* na listoch. Pri chemicky ošetrovanom variante na sledovaných parcelách sme zistili, že nepriedušne uzavreté parcely, na ktorých sa nevykonali zelené prace, mali napadnutú odrodu Lipovina a Muškát žltý v termíne ako neošetrovaný variant. Vinič na lokalitách s nadmorskou výškou 105 -150 m. n. m bez vykonaných zelených prác bol silnejšie napadnutý chorobou ako vinič vyššie pestovaný (320 m.n.m). V poraste sa dlhšie udržuje ovlhčenie listov a tak vytvára priaznivé podmienky pre rozvoj patogéna. V pokuse sme potvrdili poznatky autorov [6], že teploty vyššie ako 16 °C rozdielne vplývajú na objavenie sa prvých príznakov symptómov infekcie na listoch a na strapcoch (tab. 3). Naše výsledky sa zhodujú s autormi [1, 6], že intenzita napadnutia viniča peronospórou viničovou je závislá od odrodovej náchylnosti k ochoreniu, od množstva infekčného zdroja a priaznivých poveternostných podmienok.

Kľúčové slová: *Erysiphe necator*, odrody, *Plasmopara viticola*, zdroj infekcie

INTRODUCTION

The Tokay wine region is located between coordinates 48° 30' and 21° 37' to 21° 46' on South-East to South-West slopes of Zemplín highlands. The closed Tokay area (908.77 hectares), production sites and vine varieties (cv. Lipovina, cv. Yellow Muscat, cv. Furmint) are defined according to the Act No. 313/2009. Particularity of this region lies in the soil formed by Mesozoic andesite and rhyolite tuffs, mixed with skeleton of volcanic origin, which creates a favorable thermal regime and microclimate for vine cultivation [13]. Populations of Tokay vine varieties are threatened by genetic erosion [4]. Strict conditions of long-term monocultural vine cultivation and small infraspecific diversity created conditions for more aggressive pathogens behavior and an increased incidence of disease epidemics [8, 9].

Plasmopara viticola (Berk. & M.A. Curtis) Berl. &De Toni. and *Erysiphe necator* Schwein., emergence and etiology are well known, but we consider as very important to monitor and notice changes in pathogenic fungi behavior in relation to the host and the environment. In 2005-2008 within pilot experiments the susceptibility of Tokay varieties (cv. Lipovina, cv. Yellow Muscat, and cv. Furmint) to infection by *Plasmopara viticola* and *Erysiphe necator* with regard to climatic factors, site location, altitude, and stand architecture were monitored.

MATERIALS AND METHODS

Site description: Tokay wine region is situated between 48° 30' and 21° 37'-21° 46' longitude on South-East to South-West slopes of Zemplín highlands. Sites are located in cadasters of Malá Tŕňa, Veľká Tŕňa, Bara, Černochov, Čerhov, Viničky, and Slovenské Nové Mesto. Vineyards are situated at an altitude of 105-320 AMSL.

Climatic conditions: Sites belong to predominantly warm agro-climatic area (the sum of temperatures 3000-2800 Celsius degree), a very arid sub-area (KVI-VII. ≥ 150 mm), agro-climatic zone of mild winter (T_{min} minus 18 Celsius degree) with the long-term average solar radiation of 1237kWh.m^{-2}, and 932 kWh.m^{-2} per vegetation season.

During 2005-2008 we have developed the climatic characteristics of Tokay vine-growing region and documented it Walter´s climatograms (Figure 1,2,3,4). In order to assemble the characteristics we used data (temperature) from the climatic station of the Slovak Hydrometeorological Institute (SHMÚ) in Somotor. Using the rain gauge device the precipitation amount and using the Luft GBHm device the temperature and leaves exposure to the moisture were measured in Malá Tŕňa during the growing season.

Soil conditions: soils are formed on Mesozoic andesite and rhyolitic tuffs. The weathering of volcanic rocks gives them heavier clay soil, rich in potassium. As for the soil type, largely represented are brown soils.

Varieties: Furmint 65-75%, 15-20% Lipovina, and Yellow Muscat up to 10%.

Agronomical technology: in older vineyards the middle Rhine - Hesse training method and 2.20 x 1m spacings were employed, in younger ones the horizontal cordon training and 2.4 x 0.85 m spacings. The inter-row vineyard spaces are grass covered.

Variant: was formed by varieties Furmint, Lipovina, Yellow Muscat planted in a ratio of 70:20:10 on 1 hectare acreage at plots in Pahorok (1) and Makovisko (2) in Malá Tŕňa, SOU-Viničky (3), and Kate - Čelejka (4) in Slovenské Nové Mesto. Chemical preparations appropriate for the integrated agricultural production with water dose of 5oo l per hectare were applied.

Control variant: untreated varieties on acreage of 0.05 hectares.

Monitoring and diagnosis of diseases: During 2005-2008 within pilot experiments on sites in Pahorok (1) and Makovisko (2) in Malá Tŕňa, SOU-Viničky (3) Kate - Čelejka (4) in Slovenské Nové Mesto 100 leaves of each cultivar have been sampled in phenophase BBCH-13, 60, 65, 69, 75, 79, 85 and 89 from untreated and fungicide treated variants in order to diagnose diseases. Additionally - in phenophase BBCH 89 (berries ripe for harvest) 50 bunches of grapes from cv. Lipovina, Yellow Muscat and Furmint from untreated and fungicide treated variants were sampled in order to diagnose diseases, too. Microscopical preparations have been prepared from these samples using 50% lactic acid, resp. lactofenol with blue aniline added. Using Zeiss-Amplival light microscope the fungi type was determined, the biometric data recorded and photomicrographs have been made. Fungi determining keys and monographs [2, 3, 16, 20, 21, and 22] were used for fungi species determination. Herbarium material is deposed in the Mycological herbarium of the Botanical Institute of the Slovak Academy of Sciences.

Evaluation of vine infestation: The infestation degree of leaves and grape bunches were evaluated by Townsend and Heuberger formula (1943):

$$P\% = \frac{(n.\ v).100}{x.\ N}$$

P% - infestation degree in %

n - number of leaves in each infestation category
v - number values of infestation category (scale values)
x - total number of evaluated leaves
N - the highest possible infestation level

RESULTS AND DISCUSSION

In 2005-2008, according to the methodology, the *Plasmopara viticola* (Berk. et M.A.Curtis) Berl. et de Toni. have been diagnosed microscopically on vine leaves with the incidence of different sized yellow to brown oily stains with white flocky fungi coatings underneath (Fig. 11 A) and sporangiophora (Fig.11B, C).

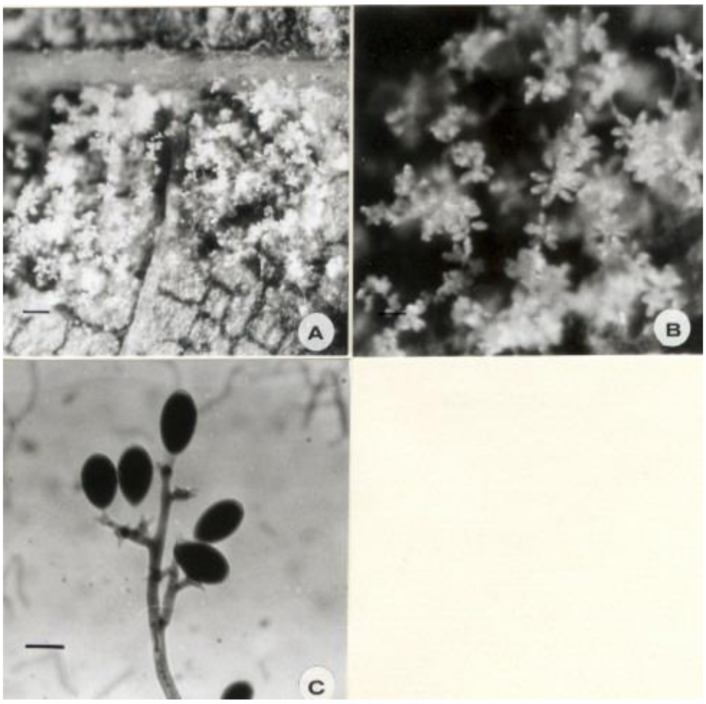

Figure 11. Microphotographic images of *Plasmopara viticola.*
Obrázok 11.Mikrofotografické zobrazenie *Plasmopara viticola.*

The formation and development of *Plasmopara viticola* is directly dependent on weather, (Fig. 1, 2, 3, 4). As we were interested in which phenophase the Tokay varieties are most sensitive to pathogens, we had to monitor the weather impact on the phenophase onset (BBCH). After determining the date in which Furmint, Lipovina, and Yellow Muscat onset into single phenophase and compared to other research results [18] we found out that the Tokay grape varieties onset into phenophases with only slight variation, except the 2007, when the vegetation due to warm weather were shifted for 14 days (Table 1).
According to microscopic observations of leaves and bunches of grapes we found out differences in infestation by *Plasmopara viticola* in different varieties. The assessment of varieties susceptibility to *Plasmopara viticola* attack was based on the last research results [18] where author characterized the Furmint variety as slightly resistant, the Lipovina variety as very sensitive and Yellow Muscat as moderately susceptible to downy mildew infection.

The intensity of infestation was evaluated by Townsend and Heuberger formula (1943) and reported in Table 4. Table 3 details the appearance of first symptoms of *Plasmopara viticola*, depending on weather course and crop architecture. First symptoms after *Plasmopara viticola* infection were found in 21 June 2005 on leaves of cv. Lipovina and cv. Furmint (Table 3). On plots treated by fungicides in Kate Čelejka, SOU- Viničky and Makovisko Malá Tŕňa, which are closed, airtight and have not undergone any green work, we found an infected cv. Lipovina and Yellow Muscat at the same date. On the contrary, on cv. Furmint from Kate Čelejka site, which is airy and where the green works have been made, any symptoms were found. In 2006, the first symptoms of *Plasmopara viticola* appeared on leaves of control variant in cv. Lipovina and Furmint on June 12 (Table 3). In 2007, the first symptoms were found already on June 8 on cv. Lipovina (Table 3). Also in 2008, we experienced the first symptoms on June 19 on cv. Lipovina (Table 3).

In pilot experiments, during 2005-2008, the most sensitive respond to *Plasmopara viticola* infection were observed in cv. Lipovina (Figure 4) which confirmed the recent research results from this area [18]. The cv. Lipovina compared to cv. Furmint and cv. Yellow Muscat has very fine leaves, which allows the fungi to penetrate more easily through cuticle by its initial fibre. Moderately sensitive respond to the infection by *Plasmopara viticola* was observed in cv. Furmint, at least sensitively responded the cv. Yellow Muscat.

According to our observations the most vulnerable period as for vine infection by *Plasmopara viticola* is during the phenophase BBCH 68, when 80% of flowers past blossoming. Table 4 shows that in 2005 on untreated variants (1),(2),(3),(4) and in all varieties has been experienced that 92-97% of leaves were infested by *Plasmopara viticola*. Similar results were stated also by authors in [6]. In 2006, the infestation degree ranged from 80 to 87%. The lowest infestation degree of 61-67% was recorded in 2007, when conditions were not suitable for disease development. In 2008, varieties were infected by 76-92%.

Within the phenophase BBCH 69 on 26 June 2008 hail damage occurred, which created favorable conditions not only for infection by *Plasmopara viticola* but for that of *Botrytis cinerea Pers*., too.

Strong incidence of downy mildew was recorded in 2005, 2006 and 2008 (Figure 5, 6, 7). We found out that in terms of vine downy mildew epidemiology the infection periods are critical, which means that the conditions for sporulation, germination and infection are opportune.

Within the pilot experiments during 2005-2008 we found out that the site microclimate, cut measures, green work and vine cultivation methods affect the infection and spread of vine diseases. The vineyards, which were located on airy sites at higher altitude, where the cut measures, green work and the robbing of shoots have been done, were less infected by *Plasmopara viticola*. On contrary, in vineyards where the vines are planted at lower altitudes in closed basins (Černochov, Pahorok), and due to lower air circulation a longer exposure of leaves to moisture is maintained which caused in 2008 a strong infestation by *Plasmopara viticola* and *Botrytis cinerea,* so that in this vegetation season the grapes were not harvested at all. Those infected leaves and grapes have become infection source for this site in 2009. In the experiment we have confirmed the results of authors [6] that temperatures higher than 16 Celsius degree impact differently the appearance of first infection symptoms on leaves and grape bunches (Table 3). The first symptoms on leaves appeared in 7 days, but a symptom on grape bunches appeared about 7-10 days later. This should be taken into account when setting the date of vine treatment.

Our results confirm the observations [1, 6] that the infestation intensity by vine downy mildew depends on varietal susceptibility to the disease, the size of infectious source and favorable weather conditions.

In 2004-2008, we observed microscopically (according to the methodology) leaves sampled in phenophase BBCH 13, 60, 65, 69, 75, 79, 85 and 89 and bunches of grapes in phenophase 89 from untreated and fungicide treated variants infected by *Erysiphe necator* and found out differences in single vine varieties infestation (Figure 4) on evaluated sites.

On microscopic preparations made from sampled leaves and berries of cv. Furmint, Yellow Muscat and Lipovina in BBCH 89 have been observed fine white or grey-white semipersistent mycelia and spherical, yellow to dark-brown fungi ascocarps (cleisthotecia) in various stages of their development (Fig. 12A) . Conidial (anamorphic) stage of fungi consisted of filamentous fungi hyphae (mycelia) (Fig. 12E). On persistent mycelium upright long conidiophores with conidia were formed. Apical fiber was short, sometimes twisted and ended by lobed appressorium (Fig.12F). Teleomorph - sexual reproductive stage of fungi were formed by black-brown cleistothecia, irregularly spherical, scattered singly or in groups (Fig. 12 B, C). Peridia cleistothecia cells are polygonal to round. Pendants on mature cleistothecia (10-25) grow radially and are 1-3 times longer than cleistothecia diameter, hyaline to brown, segmented, straight or slightly curved arch up, and simple, hooked to curve at the end (Fig. 12D).

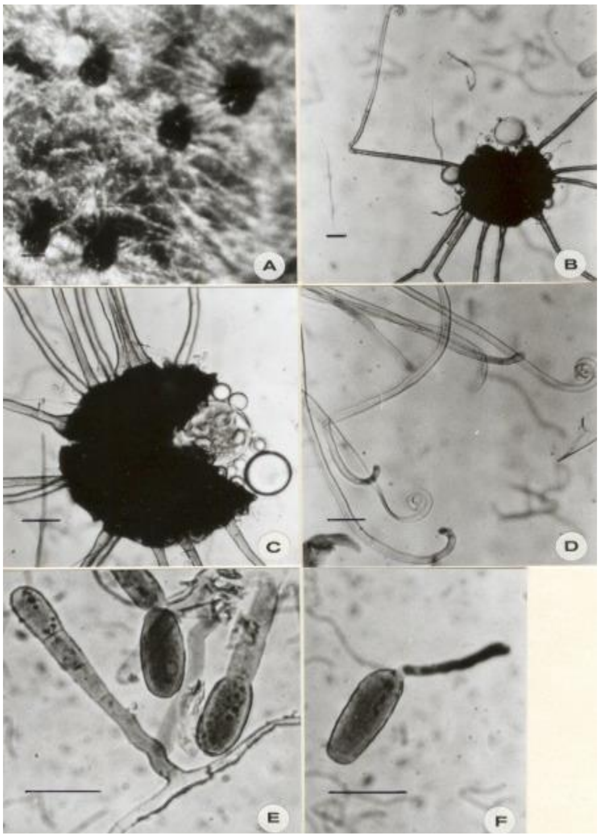

Figure 12. Microphotographic images of vine mildew *Erysiphe necator* .
Obrázok 12. Mikrofotografické zobrazenie *Erysiphe necator* .

Our observations correspond with research results [5, 7, 8, 9, 10, 11, and 12]. Authors [11] confirmed this in observations obtained during 2001-2003 in 29 South-Italian vineyards that overwintering of *Erysiphe necator* mycelia or cleistothecia depends on the vine-production area. Flag shoots were found in one-third of vineyards, with a frequency highly variable between the year and vineyard, occurring more frequently in wine- than table-grape production vineyards. An average of 20% flag shoots was present on the same vine and arm as in the previous year, and 75% of them originate from three proximal cane buds. Cleistothecia were found in 46% of monitored vineyards, in leaves and bark, but not in the soil. In spring there were between 3 and 856 cleistothecia*g of leaf tissue with a viability of 7%, whereas in the bark between 2 and 464 overwintering cleistothecia*g of bark were found, with an average viability of 14%.

The main source of primary infection is cleistothecia [12]. Similar observations were made by producers in the area of Bordeaux who have often reported the first signs of mildew after blooming. In Eger wine region, Hungary, only once for 12 years – in 2004, an overwintering mycelium fungi stage was reported [10]. Authors [12] examined which of the two overwintering forms of *Erysiphe necator* dominates in different vine-growing regions in Hungary, in order to find out its impact on the disease outbreak initiation. The only evidence of mycelia overwintering of this fungal pathogen in grapevine buds in 2004 was found in one Sióagárd vineyard where only one plant showed the typical symptoms of “flag shoot”, whereas in all other cases initial infections by ascospores from overwintering cleistothecia were evident.

The cleistothecia of fungi do not form every year and in some areas of the world do not even differentiate [2, 15, and 21]. On the contrary, the authors [15] argue that cleistothecia in conditions of the Czech Republic does create on an annual basis, but the bags and ascospores maturation occurs only in years with warm and dry autumn (for example in 1993, and 1994).

In pilot experiment on observed sites the temperature dropped down to minus 21, 4 Celsius degree in February 2005 and to minus 24 Celsius degree in January 2006 so the fungi mycelium has been destroyed. Any leaves infected by mycelium were found, but nevertheless were found symptoms on leaves evenly extended on sites.

Our results confirmed the presence of cleistothecia and in years 2005-2006 they became the primary source of ascospore infection. In pilot experiments have been found that the infectious ability of ascospores is affected by their overwintering and maturity.

We found that the cold period of rainfall in autumn is not suitable for cleistothecia formation, while dry autumn prevents their transfer to trunk. This is confirmed by [10], too.

Cleistothecia may have significant epidemiological significance in the Tokay region, because they are resistant to winter frosts and the infection occurs almost from the phase of 2-3 leaves in different conditions, which increases the possibility of rapid disease development. Ascospores release and the infection occur when exposed to the moisture. According to the research results in the Tokay vine-growing region it is important to identify infection sources in autumn in order to develop vineyard protection measures regarding the primary infection source.

During 2005-2008 we have investigated the incidence of *Erysiphe necator* on single varieties in variants 1, 2, 3, 4 (Table 2) and compared them to last research results [18]. We found out that the infection of leaves by *Erysiphe necator* in studied varieties depends on their susceptibility and sensitivity. The most sensitive respond to the powdery mildew infection was observed in cv. Lipovina, thus confirmed the last research results [18]. Lipovina has a very thin and soft leaf, which is crucial for easy penetration and infection by fungi. Older leaves are more resistant to the infection. Primary infection occurs in spring on the back of the leaf and thereby creates a strong infection pressure on grape bunches and berries.

For infection of bunches more important then weather is the presence and size of infection source.

On untreated variants on sites (1) and (3) the first infection symptoms on cv. Lipovina were observed on 11 July 2005 (Table 2). In 2006, the symptoms have been indentified on 9 July (Table 2).

Extremely dry and warm autumn in 2006 created favorable conditions for strong cleistothecia occurrence, but because of precipitation scarcity during the last quarter of this year they were not washed to the trunk. Isolated symptoms of mycelium infection were found on 7 May 2007 on the first leaves of vine shoots. On June 26 symptoms were found on leaves and grape bunches, too. On May 2-3 ground frost of minus 4 Celsius degree caused the vine winterkill at some sites.

Table 4 shows that in 2005 we experienced 56-75% infestation by *Erysiphe necator* on leaves of untreated variants in all varieties. In 2006, the infestation degree ranged from 56-65%. In 2007 it was 59-78%. In 2008 the infestation of all variants and in all varieties ranged from 54 to 62%.

Our results from 2005-2008 showed that the most vulnerable period for infection by vine powdery mildew is the phenophase BBCH 68, when 80% of flowers fade away. Similar results were stated also by [7]. We also found that the longer the period from the beginning to the end of flowering, the longer the period for infection. Infection can occur already by flowering (2005, 2006) while fungi caused wilting of some grape bunches. Congested bushes give more favorable conditions for fungi development.

New knowledge on the biology and ecology of *Erysiphe necator* and its overwintering on vine in given ecological conditions (in oidia and teleomorph stage of fungi) are an important knowledge, especially in terms of integrated vine protection regarding the primary infection source. Based on international findings [5, 10, 11,] results obtained during 2005-2008 can´t be taken indifferent, and it is necessary to count with them in the vineyard protection.

The most sensitive response to infection by both diseases was observed in cv. Lipovina, medium strong in cv. Furmint and the smallest in cv. Yellow Muscat. According on our results from 2005-2008 follows that in addition to climatic conditions and varietal susceptibility most crucial for *Erysiphe necator* and *Plasmopara viticola* development is the vineyard location, an altitude and the vegetation density, which correlates with results obtained by other authors [1, 5, 6, 7, 9, 15]

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Table 1. BBCH phenophases in cv. Furmint, Lipovina and Yellow Muscat; sites: Pahorok, Malá Tŕňa, 2005 – 2008
Tabuľka 1. Fenofázy BBCH stupnice v odrodách Furmint, Lipovina a Muškát žltý Pahorok, Malá Tŕňa, 2005 – 2008

BBCH (1)	BBCH start (3) 2005	BBCH start 2006	BBCH start 2007	BBCH start 2008	BBCH Pospíšilová start	Varieties (4)
01	23.3.05	10.4.06	11.3.07	31.3.08		
08	18.4. 05	20.4. 06	5.4. 07	15.4.08		
13-15	30.5. 05	20.5. 06	4.5. 07	12.5.08		
60	15.6. 05 17.6. 05 17.6. 05	17.6. 06 18.6. 06 18.6. 06	28.5. 07 30.5. 07 30.5. 07	9.6.08 11.6.08 11.6.08		Furmint Lipovina, Yellow Muscat
65	14.6. 05 20.6. 05 22.6. 05 22.6. 06 30.6. 05	14.6. 06 21.6. 06 22.6. 06 22.6. 06	30.5. 07 2.6. 07 3.6. 07 3.6. 07	6.6.08 11.6.08 13.6.08 13.6.08	27.5 - 10.6 15.6. 9.6.	Rulanské biele Furmint Lipovina Yellow Muscat Lipovina-Čelejka
69	25.6. 05	25.6. 06	6.6. 07	16.6.08		
75	11.7. 05	10.7. 06	25.6.07	16.7.08		
79	21.7. 05 23.7. 05 23.7. 05	25.7. 06 27.7. 06 27.7. 06	9.7. 07	2.8. 08 5.8. 08 7.8. 08		Yellow Muscat Furmint, Lipovina
85	23.8. 05 25.8. 05 25.8. 05	15.8. 06 17.8. 06 17.8. 06	20.8.07	15.8. 08 18.8. 08 20.8. 08		Yellow Muscat Furmint, Lipovina
89	17.10. 05	10.10. 06 16.10. 06	1.10.07	13.10.08		Yellow Muscat Furmint, Lipovina
Harvest of raisins (2)	24.10. 05	23.10. 06	16.10.07	without harvest		

BBCH(1) Vegetation stage, 01- Beginning of bud swelling: buds begin to expand inside the bud scales, 08- Bud burst: green shoot tips clearly visible, 13-15- Shoots of 0.4-0.5m, 60- Before flowering, 65- Flowering, 69- At the end of flowering, 75- Pea size berries, 79- Majority of berries touching, 85- Berries softening, 89- Berries ripe for harvest.
(1) Vegetation stage, (2) Harvest of raisins, (3) BBCH start, (4) Varieties

BBCH (1) vegetatívne štádium, 01 – začiatok pučania, 08 – púčik praská: jasne viditeľné zelené končeky, 13-15 – vetvy s listami dlhé 0.4-0.5 m, 60 – pred kvetom,

65 – kvitnutie, 69 – koniec kvitnutia, 75 – bobule veľkosti hrášku, 79 – väčšina bobúľ vytvorených, 85 – mäknutie bobúľ, 89 – zberová zrelosť bobúľ
(1) vegetatívne štádium, (2) zber hrozienok, (3) začiatok BBCH, (4) odrody

Table 2. Onset date of *Plasmopara viticola* symptoms on vine leaves in Tokay region
Tabuľka 2. Dátum nástupu symptómov *Plasmopara viticola* na listoch viniča v Tokajskej vinohradníckej oblasti

Year	Varieties	Beginning of flowering	Symptoms on leaves	Symptoms on grape bunches	Infection pressure
2005	Furmint Lipovina, Yellow Muscat	15.6. 05 17.6. 05 17.6. 05	11.7.2005 BBCH75	21.7.2005 BBCH76	Medium
2006	Furmint Lipovina, Yellow Muscat	17.6. 06 18.6. 06 18.6. 06	9.7.2006 BBCH75	18.7.2006 BBCH76	Medium
2007	Furmint Lipovina, Yellow Muscat	28.5. 07 30.5. 07 30.5. 07	26.6.2007 BBCH75 7.5.2007 prvý list	26.6.2007 BBCH75	Strong
2008	Furmint Lipovina, Yellow Muscat	9.6.08 11.6.08 11.6.08	6.7.2008 BBCH75	21.7.2008 BBCH76	Medium

Table 3. Onset date of *Erysiphe necator* symptoms on vine leaves in Tokay region
Tabuľka 3. Dátum nástupu symptómov *Erysiphe necator* na listoch viniča v Tokajskej vinohradníckej oblasti

Year	Varieties	Beginning of flowering	Symptoms on leaves	Symptoms on grape bunches	Infectiuon pressure
2005	Furmint Lipovina, Yellow Muscat	15.6. 05 17.6. 05 17.6. 05	21.6.2005 BBCH65	30.6.2005 BBCH69	Strong
2006	Furmint Lipovina, Yellow Muscat	17.6. 06 18.6. 06 18.6. 06	12.6.2006 BBCH60	28.6.2006 BBCH69	Strong
2007	Furmint Lipovina, Yellow Muscat	28.5. 07 30.5. 07 30.5. 07	8.6.2007 BBCH69	22.6.2007 BBCH75	Medium
2008	Furmint Lipovina, Yellow Muscat	9.6.08 11.6.08 11.6.08	19.6.2008 BBCH69	29.6.2008 BBCH75	Strong

Table 4. The occurrence (in %) of *Plasmopara viticola* and *Erysiphe necator* on vine leaves in Pahorok (1), Makovisko (2) Malá Tŕňa (3), SOU Viničky (3),Kate-Bara (4)
Tabuľka 4. Výskyt infekcie (v %) of *Plasmopara viticola a Erysiphe necator* na listoch viniča v lokalite Pahorok (1), Makovisko (2) Malá Tŕňa (3), SOU Viničky (3) a Kate-Bara (4)

Disease (1)	Variety (2)	Occurrence in % (3) 2005				Occurrence in % 2006				Occurrence in % 2007				Occurrence in % 2008			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Plasmopara viticola	Lipovina	97	69	78	82	69	60	61	71	67	66	63	65	92	75	82	77
	Furmint	95	55	69	78	55	52	51	63	65	60	55	61	81	71	78	70
	Yellow Muscat	92	52	62	65	52	55	50	54	61	53	51	55	76	66	66	68
Erysiphe necator	Lipovina	75	37	55	48	65	35	51	55	78	48	74	72	62	41	52	57
	Furmint	64	31	34	39	62	32	32	38	68	45	65	66	57	37	47	45
	Yellow Muscat	59	28	29	32	56	27	26	27	59	39	59	57	54	28	41	32

Figure 1. Walter´s Climatogram 2005
Obrázok 1. Walterov klimatogram 2005

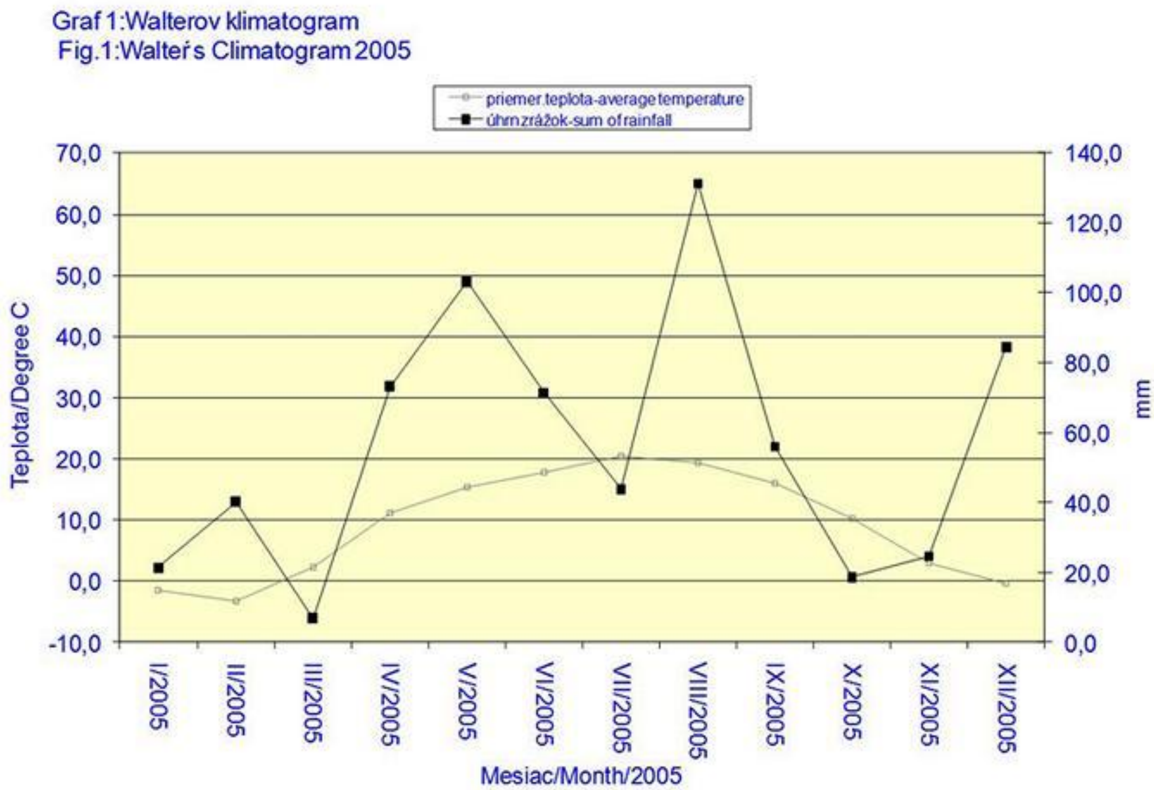


Figure 2. Walter´s Climatogram 2006
Obrázok 2. Walterov klimatogram 2006

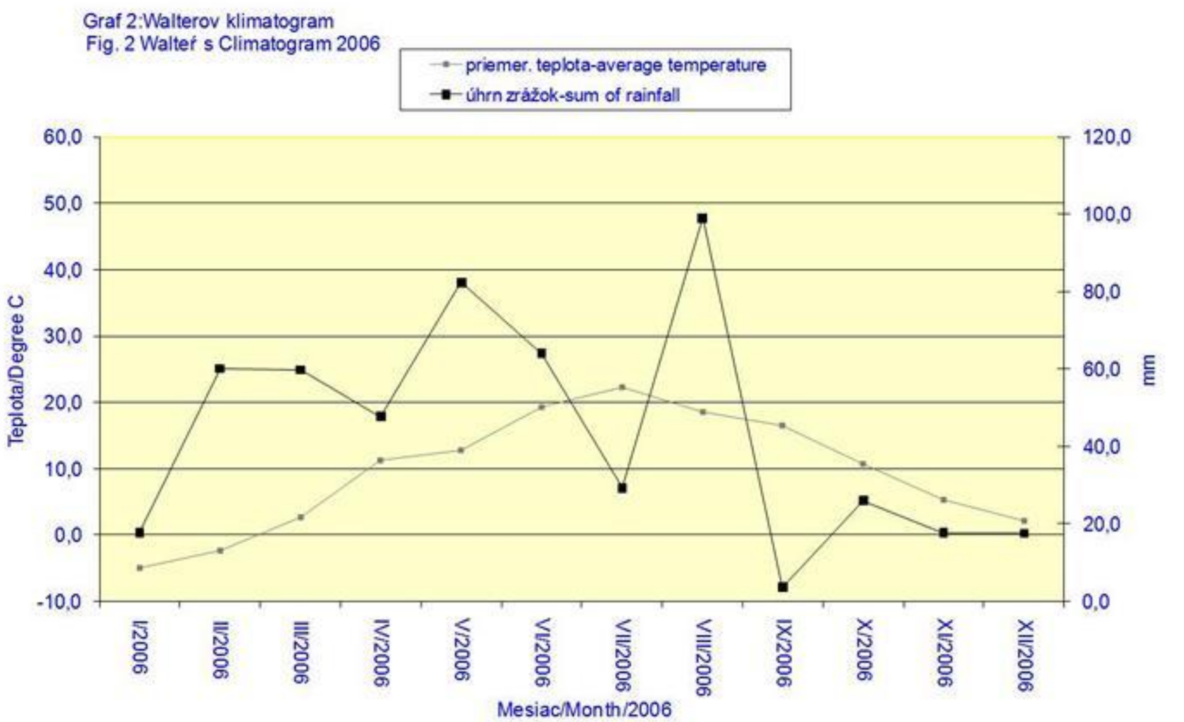


Figure 3. Walter´s Climatogram 2007
Obrázok 3. Walterov klimatogram 2007

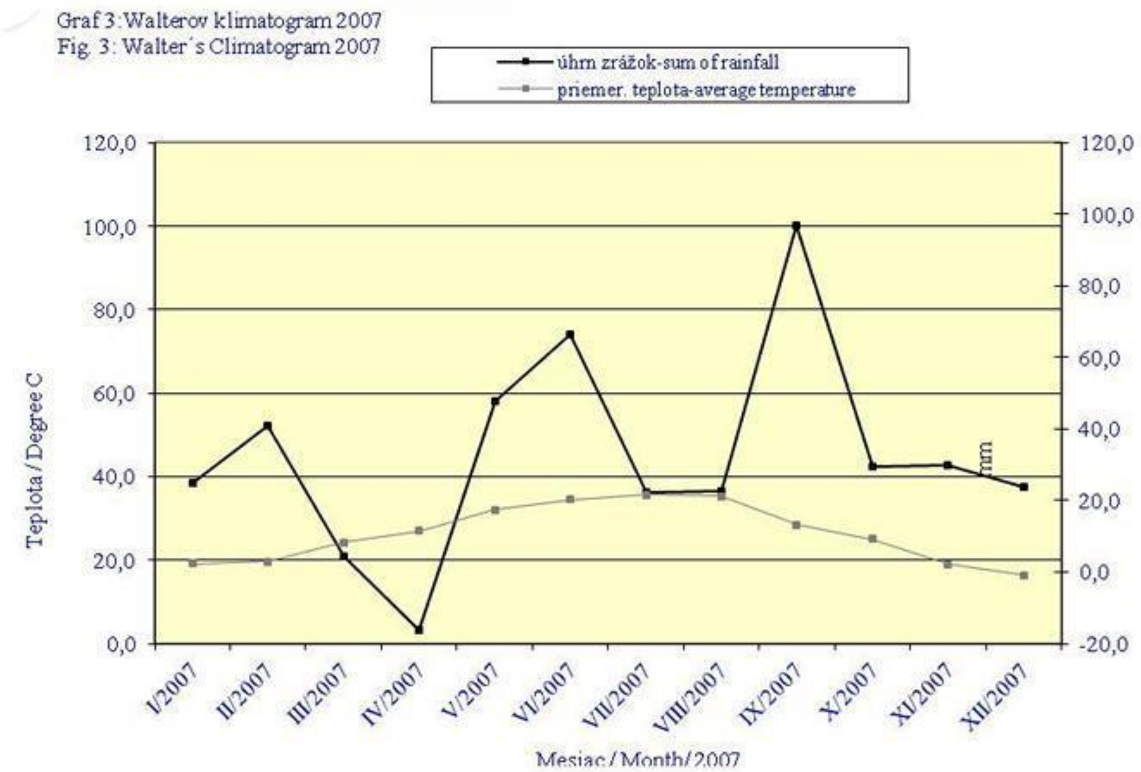


Figure 4. Walter´s Climatogram 2008
Obrázok 4. Walterov klimatogram 2008

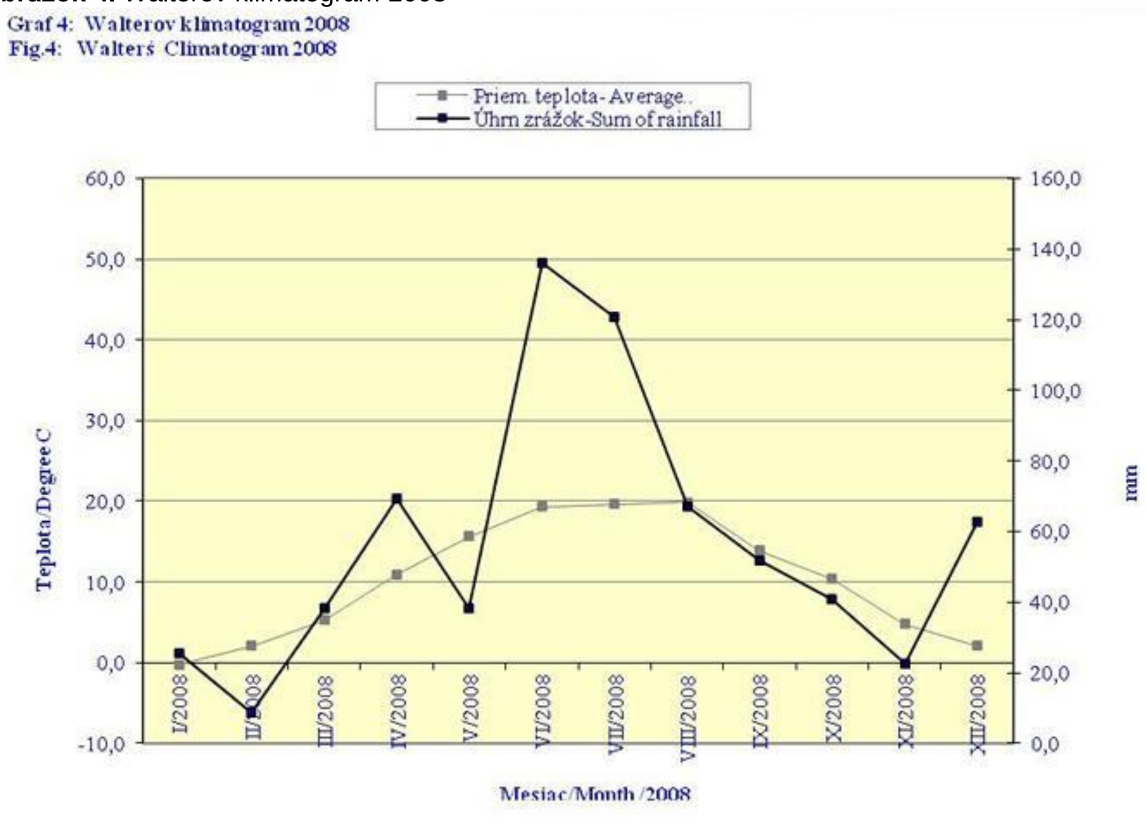
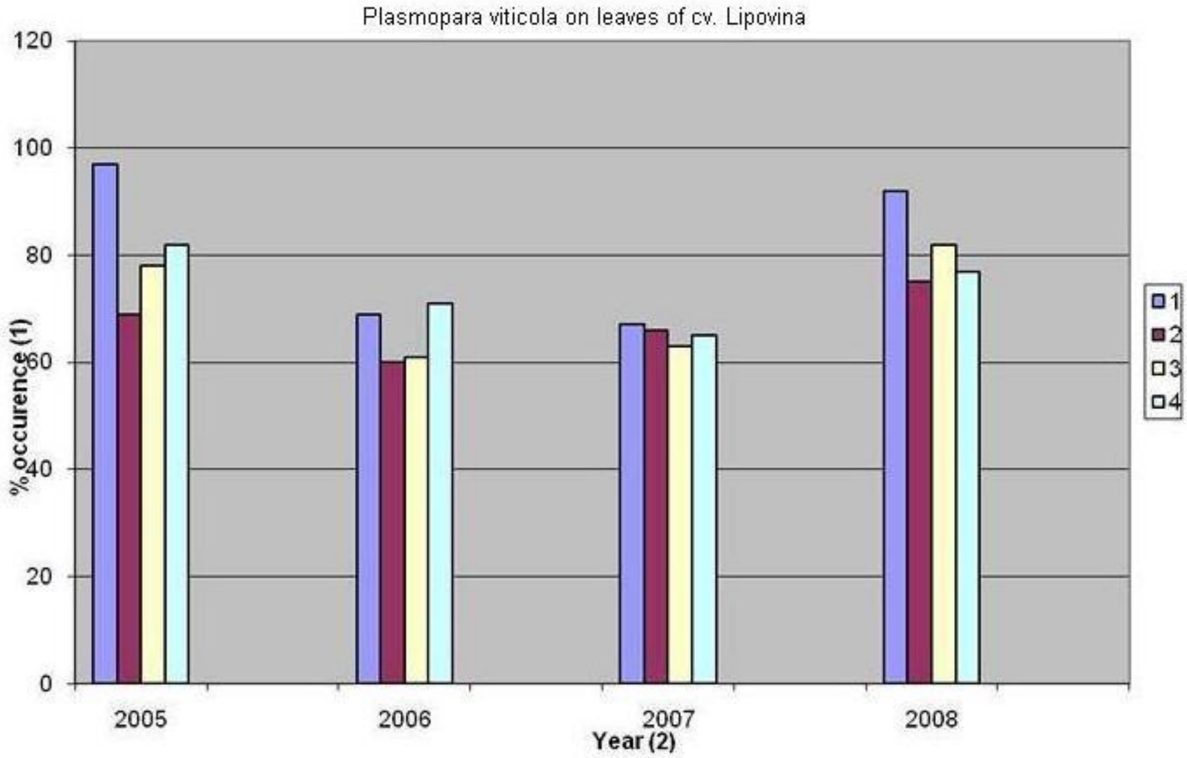
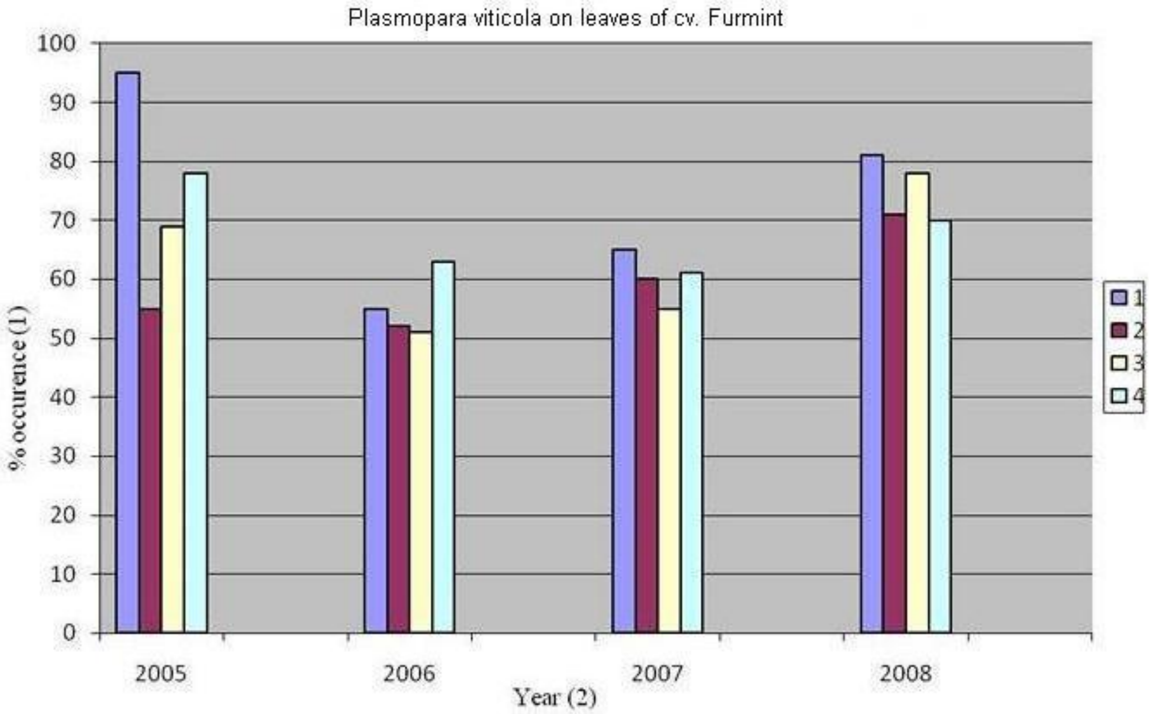


Figure 5. The percentage of *Plasmopara viticola* infection on leaves of cv. Lipovina
Obrázok 5. Percento infekcie *Plasmopara viticola* na listoch odrody Lipovina



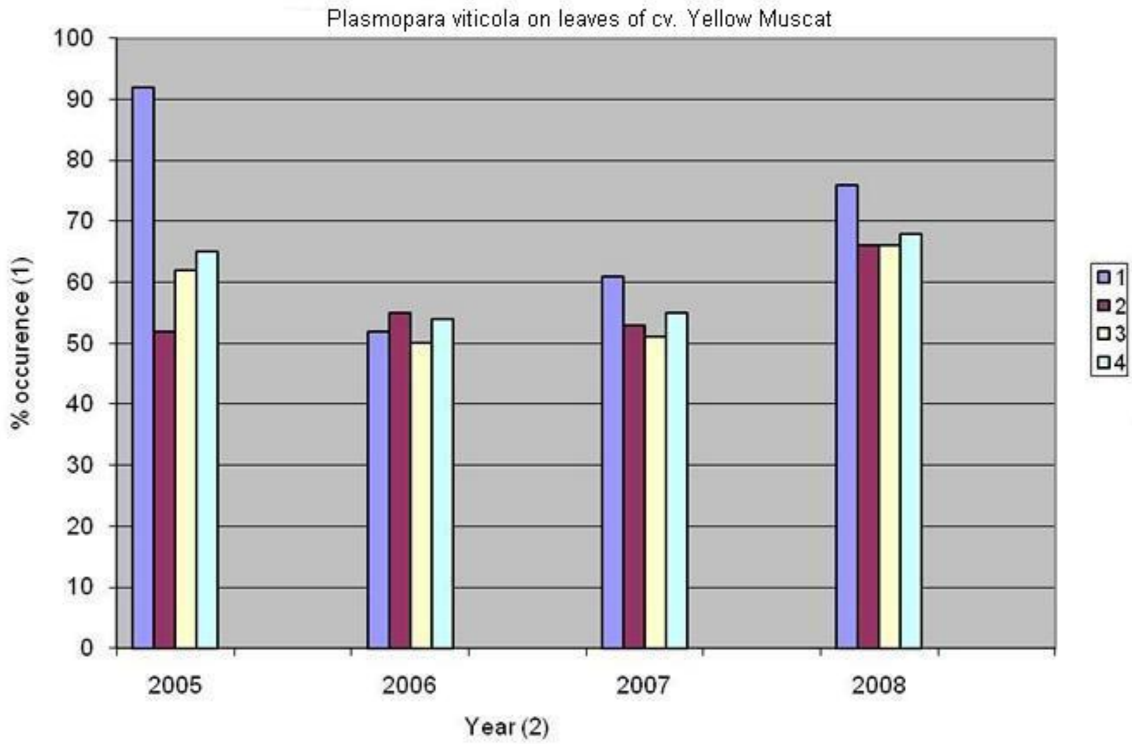
(1) Percentage of infection, (2) year
(1) Percento infekcie , (2) rok

Figure 6. The percentage of *Plasmopara viticola* infection on leaves of cv. Furmint
Obrázok 6. Percento infekcie *Plasmopara viticola* na listoch odrody Furmint



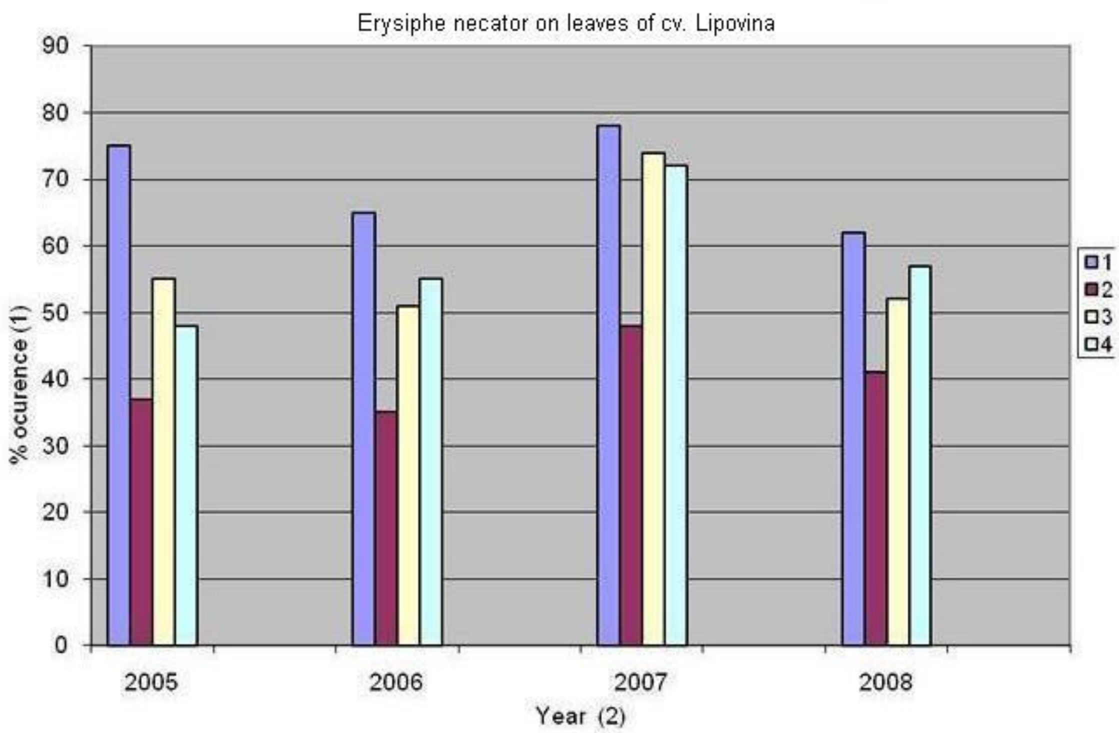
(1) Percentage of infection, (2) year
(1) Percento infekcie , (2) rok

Figure 7. The percentage of *Plasmopara viticola* infection on leaves of cv. Yellow Muscat
Obrázok 7. Percento infekcie *Plasmopara viticola* na listoch odrody Žltý muškát



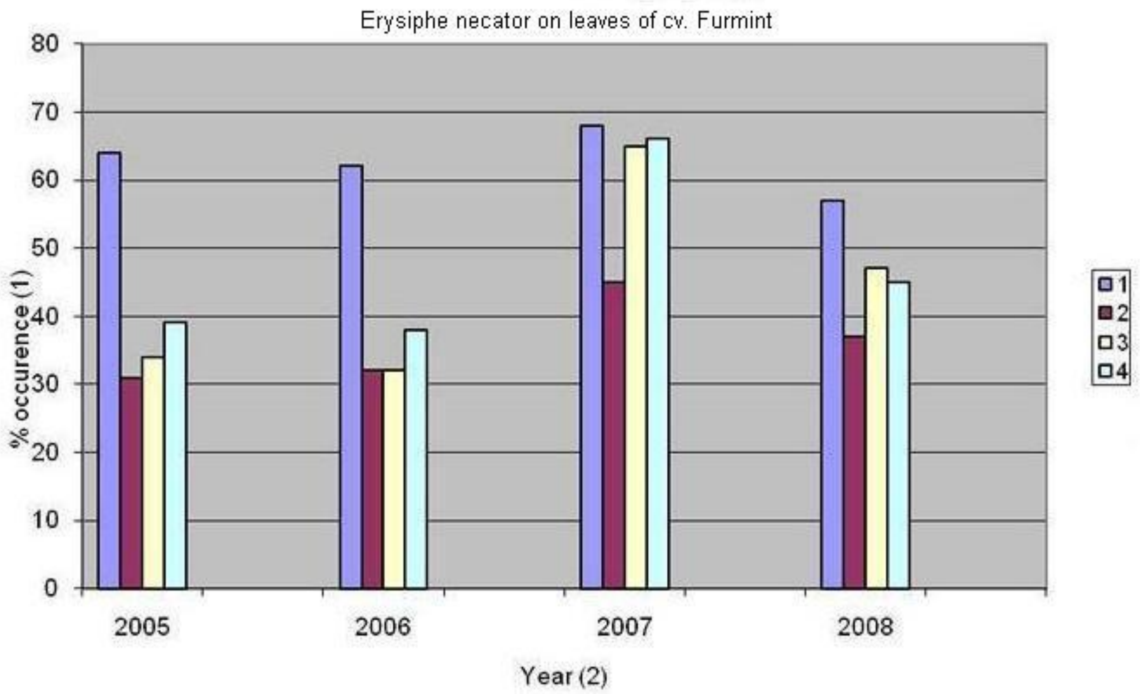
(1) Percentage of infection, (2) year
(1) Percento infekcie, (2) rok

Figure 8. The percentage of *Erysiphe necator* infection on cv. Lipovina leaves
Obrázok 8. Percento infekcie *Erysiphe necator* na listoch odrody Lipovina



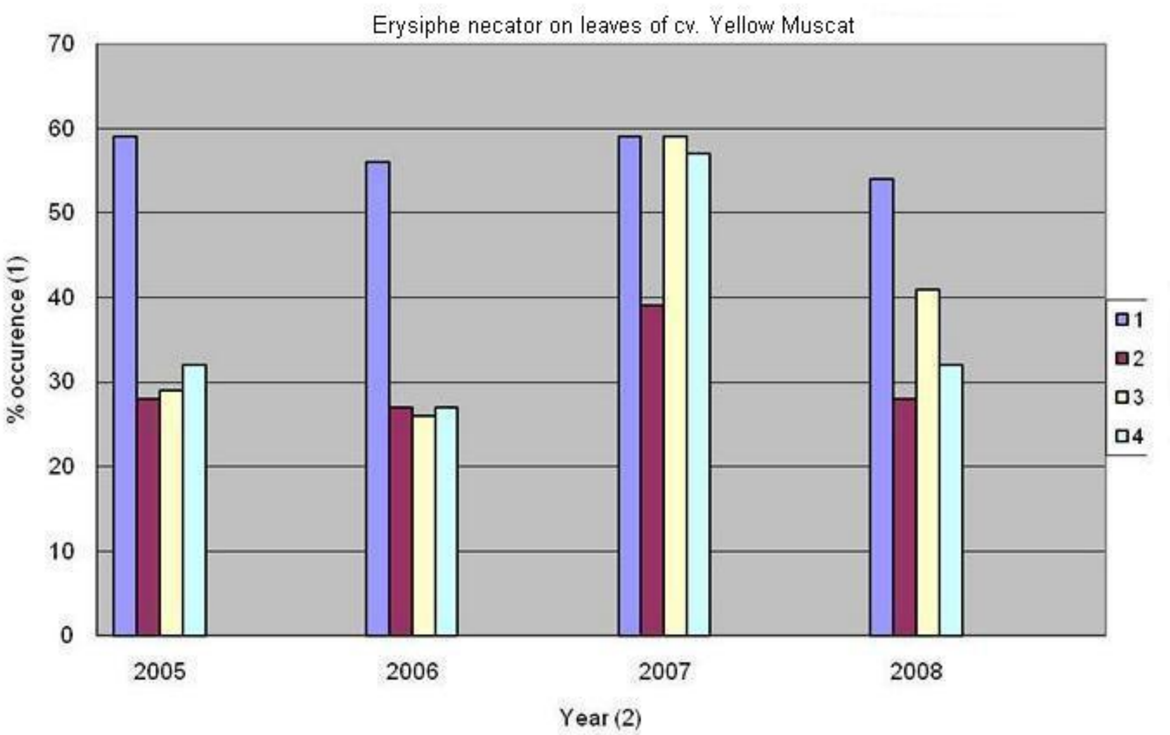
(1) Percentage of infection, (2) year
(1) Percento infekcie, (2) rok

Figure 9. The percentage of *Erysiphe necator* infection on cv. Furmint leaves
Obrázok 9. Percento infekcie *Erysiphe necator* na listoch odrody Furmint



(1) Infection percentage, (2) year
(1) Percento infekcie , (2) rok

Figure 10. The percentage of *Erysiphe necator* infection on leaves of cv. Yellow Muscat
Obrázok 10. Percento infekcie *Erysiphe necator* na listoch odrody Žltý muškát



(1) Percentage of infection, (2) year
(1) Percento infekcie, (2) rok